ONKOLOGIE

Original Article · Originalarbeit

Onkologie 2011;34:614–618
DOI: 10.1159/000334063

Published online: October 28, 2011

# Comparison of Actual Hospital Costs versus DRG Revenues for In-Patient Treatment of Febrile Neutropenia during Adjuvant Anthracycline plus/minus Taxane-Based Chemotherapy for Primary Breast Cancer

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**Keywords**

Economics · Chemotherapy · Febrile neutropenia · Cost-revenue calculation · DRG reimbursement

**Schlüsselwörter**

Wirtschaftlichkeit · Chemotherapie · Neutropenie, febrile · Kosten-Erlös-Kalkulation · DRG-Erlöse

## Summary

**Background:** In flat-rate reimbursement systems, the hospital's own costs should not exceed its revenues. In a cohort of primary breast cancer (pBC) patients, costs and reimbursement for febrile neutropenia (FN) were compared to verify cost coverage. **Methods:** A prospective, observational study in pBC patients receiving adjuvant anthracycline ± taxane-based chemotherapy calculated the costs per in-patient FN episode. The correlating revenues were retrospectively analyzed from diagnosis-related group (DRG) invoices. The actual costs of the therapies were compared to the individual DRG revenues, and the results are presented from the provider's perspective. **Results:** In 50 patients, n = 11 patients were treated for FN as in-patients. The hospital's overall treatment costs were € 18,288, on average (Ø) € 1663 per case (range € 1139–2344); the overall DRG revenues were € 23,593, Ø € 2145 per case (range € 1266–2660). In n = 8 cases, the DRGs were cost covering, and in n = 3 cases, a loss was observed, but overall resulting in a gain of Ø € 482 per case and thus being cost covering for the provider. Inadequate DRG coding (n = 4/11; 36.4%) resulted in a preventable loss of Ø € 1069/case. **Conclusions:** The costs of FN treatment vary substantially and DRG reimbursements do not necessarily reflect the provider's costs. Surprisingly, the in-patient treatment of FN here is overall more than cost covering if adequately coded. The main reasons are asymmetrical costs for this FN low-risk pBC group. These results emphasize the importance of correct medical coding to avoid potential losses.

## Zusammenfassung

**Hintergrund:** In Fallgruppen-Systemen mit pauschaler Kostenerstattung sollten die Eigenkosten der Klinik deren Erlöse nicht überschreiten. In einer Kohortenstudie an Patientinnen mit primärem Mammakarzinom (pMK) wurden Kosten und Erlöse bei febriler Neutropenie (FN) zum Nachweis der Kostendeckung verglichen. **Methoden:** Eine prospektive Beobachtungsstudie beim pMK mit adjuvanter Anthrazyklin ± Taxan-basierter Chemotherapie analysierte die Kosten für die stationäre FN-Behandlung. Retrospektiv wurden diesen die dazugehörigen Erlöse der diagnosebezogenen Fallgruppen (DRG)-Rechnungen gegenübergestellt. Die tatsächlichen Therapiekosten wurden dabei mit den individuellen DRG-Erlösen verglichen und die Ergebnisse aus Kliniksicht dargestellt. **Ergebnisse:** Von 50 Patienten wurden n = 11 stationär wegen FN behandelt. Die gesamten Behandlungskosten des Krankenhauses betrugen 18 288 €, im Durchschnitt (Ø) 1663 € pro Fall (1139–2344 €); die gesamten DRG-Erlöse betrugen 23 593 €, Ø 2145 € pro Fall (1266–2660 €). In n = 8 Fällen waren die DRGs kostendeckend, in n = 3 verlustbringend, aber insgesamt resultierte ein Gewinn von Ø 482 € pro Fall und somit Kostendeckung aus Kliniksicht. Fehlerhafte DRG-Kodierung (n = 4/11; 36,4%) führte zu einem vermeidbaren Verlust von Ø 1069 € pro Fall. **Schlussfolgerungen:** Die Kosten der FN-Behandlung im Krankenhaus variieren stark. DRG-Erlöse stellen nicht zwingend die Klinikkosten dar. Überraschenderweise ist die stationäre FN-Behandlung mehr als kostendeckend, wenn angemessen kodiert wird. Hauptursache sind asymmetrische Kosten bei dieser FN-Niedrigrisikogruppe mit pMK. Die Ergebnisse unterstreichen die Bedeutung der korrekten medizinischen Kodierung zur Vermeidung von Verlusten.

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0378-584X/11/3411-0614$38.00/0

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## Introduction

Febrile neutropenia (FN) is an undesired effect of myelosuppressive chemotherapy (CTX) in many different kinds of cancer [1]. The FN rates depend on the type and dose of oncologic medication used, with ranges roughly between 5 and 30% for breast cancer [2]. To prevent FN, guidelines recommend primary prophylactic use of granulocyte colony-stimulating factor (G-CSF) at expected FN rates of ≥ 20% [2]. Often an in-patient stay in hospital for several days is required to diagnose and treat fever and potential infection symptoms until the nadir of the low white blood count (WBC) due to the CTX-related myelosuppressive immunoreaction is resolved and the WBC is rising or back to normal.

However, in a flat-rate diagnosis-related group (DRG) reimbursement system, a hospital's own costs for diagnosis and treatment as well as for material expenses [3] should not exceed the actual reimbursement, which equals the target costs from the provider's perspective. This requires a comprehensive understanding of the hospital costs, material expenses and consumption of other resources as well as adjustment and active steering processes at the operative clinic level [4]. This is even more important in entities like cancer with high resource consumption, e.g. oncological medication [5–8] or breast implants [3], especially in prophylaxis [9] and treatment of febrile neutropenia [10–12] and also in clinical trials [13, 14]. In a prospective study of primary breast cancer (pBC) patients receiving adjuvant anthracycline (A) ± taxane (T)-based CTX, the actual diagnostic and treatment costs were determined [10]. To compare and verify cost coverage of in-patient FN therapy from the provider's perspective, individual reimbursements of DRG revenues were therefore compared to the clinic's costs in an individual case-based analysis.

## Methods

Subgroup analysis of the previously published prospective, longitudinal, observational MAEGHIC-EI study [11] with adjusted selection criteria for the pBC patient cohort: diagnosis of primary non-metastasized breast cancer, indication for adjuvant CTX and exclusion of myelosuppressive therapy in their medical history, to assure a homogeneous FN risk group. Study approval from the local ethics committee was obtained and patients were recruited according to the informed consent model. All patients received a potentially myelosuppressive chemotherapy with up to 6 cycles (on average 5.4 completed cycles) of anthracycline ± taxane (60% A and 40% AT, respectively). Of all patients, 80% completed therapy, 4% had a dose reduction and 16% discontinued CTX. To identify and categorize potential comorbidity, the Eastern Cooperative Oncology Group (ECOG) status and the Charlson Comorbidity Index (CCI) were additionally determined for each patient. Clinical and resource use data as well as DRG reimbursement were analyzed from medical charts, hospital data bases, and corresponding DRG invoices.

For this patient cohort, FN was defined as fever ≥ 38 °C and an absolute neutrophil count (ANC) < $1 \times 10^9$/l (grade III/IV). Both parameters should have been documented concomitantly in the medical chart, with a maximal time difference of ±1 day. If the nadir ANC was unavailable, febrile leukopenia (FL) was assessed. Only FN episodes with in-patient stay were included for further analysis.

To evaluate the actual costs from the provider's perspective, the quantified resource use associated with an FN/FL episode was multiplied by the respective unit cost for each resource. Cost data sources used for calculation were as follows:

- drugs and blood products: local costs for supply in € of 2007
- diagnostics: internal transfer prices in € of 2007
- hospitalization: local mean daily costs in € of 2007 (€ 259.50 for normal care)

DRG coding was performed by ward-based physicians. DRG calculations were based on the DRG browser V2004/2006 HA by the Institute for the Hospital Remuneration System (InEK) [15].

Finally, the actual costs of in-patient FN/FL treatment were compared to the corresponding DRG revenues in an individual case-based analysis.

## Results

*FN Episodes*

A cohort of n = 50 pBC patients was selected according to inclusion criteria. The rate of in-patient-managed FN episodes was 22% (n = 11/50). The majority of all FN episodes were treated as in-patients (n = 11/12; 91.7%). 9 patients had 1 and 1 patient had 2 FN episodes. 1 episode, handled by an office-based gyneco-oncologist, was excluded from further cost analysis.

*Patient Demographics for Study Cohort and FN Group*

The patient demographics of the study group was as follows: all Caucasian, average age 57.5 (32–74) years, ≥ 65 years n = 13 (26%), average height 1.65 (1.50–1.83) m, average weight 68.7 (49.3–104.0) kg. Tumor information: with T1 n = 25 (50%), T2 n = 19 (38%), ≥ T3 n = 5 (10%) and pTx n = 1 (2%), divided into nodal negative n = 33 (66%) and nodal positive n = 17 (34%). The ECOG performance status for all patients was 0 (n = 50; 100%) and the CCI was n = 44 (88%) for no comorbidity, n = 6 (12%) for mild and n = 0 for severe comorbidity.

The patient demographics of the FN collective showed that they were on average 54.5 (range 32–67) years, with only n = 2 of age ≥ 65 years. The tumor status was T1 n = 5 (45.5%), T2 n = 4 (36.4%) and ≥ T3 n = 2 (18.2%), divided into lymph nodal positive n = 3 (27.3%) and nodal negative n = 8 (72.7%). The FN patients' demographic and tumor parameters showed no statistical differences compared to the total cohort of pBC patients. The mean length of hospital stay for in-patient treatment of FN was 5.4 (range 4–8) days. No patient required intensive care, but n = 3 additional out-patient visits. All patients recovered quickly without further complications.

*Resources*

The resource use during FN/FL-associated hospital treatment is summarized in table 1. All FN episodes were treated with antibiotics. Antimycotics and virustatics were not reported, as well as blood transfusions or any other blood products.

**Table 1.** Consumption of resources for in-patient therapies (n = 11) of FN during adjuvant chemotherapy of pBC

| FN/FL episodes with hospital in-patient treatment (n = 11) | Episodes with resource use, n (%) | Resource use per episode with resource use |
|---|---|---|
| | | Mean days, n (median; range) |
| Hospital care | | |
| Ward care | 11 (100) | 5.4 (5; 4–8) |
| Intensive care unit (ICU) | 0 | 0 |
| | | Mean units consumed, n |
| Antiinfective therapy | | |
| Antibiotics | 11 (100) | 28 |
| Antimycotics | 0 | 0 |
| Virustatics | 0 | 0 |
| G-CSF | 2 (18.2) | 3 |
| Epoetin | 1 (9.1) | 2 |
| Transfusions | 0 | 0 |
| Antipyretics (paracetamol) | 2 (18.2) | 2 |
| Fluid substitution | 6 (54.5) | 2 |
| Low molecular heparins | 11 (100) | 4.8 |
| Other drugs | 8 (72.7) | 16.6 |
| Imaging | 6 (54.5) | 1 |
| Microbiology | 10 (90.9) | 2 |
| Functional diagnostic | 0 | 0 |
| Blood tests* | 11 (100) | 11.5 |
| Consults | 2 (18.2) | 1 |

*Each value that could be costed was counted separately.

**Table 2.** Overview of coding, revenues and costs with DRG, main and secondary diagnosis, length of stay, DRG revenues, hospital costs and resulting gain or loss for in-patient therapy of FN during adjuvant chemotherapy of pBC

| No. | DRG | MD | SD fever | SD pharmaceutical-induced agranulocytosis | Actual LOS, days | Avg. LOS acc. to DRG, days | DRG revenue, € | Avg. revenue per day, € | Hospital costs, € | Gain (+) or loss (–), € |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Q60A | D70.10 | – | MD | 4 | 7.50 | 2659.84 | 664.96 | 1552.66 | +1107.18 |
| 2 | Q60A | D70.7 | R50.9 | – | 4 | 7.50 | 2659.84 | 664.96 | 1138.56 | +1521.28 |
| 3 | Q60A | D70.11 | – | MD | 6 | 7.50 | 2659.84 | 443.31 | 1765.71 | +894.13 |
| 4 | Q60A | D70.19 | – | – | 8 | 7.50 | 2659.84 | 332.48 | 2343.86 | +315.98 |
| 5 | Q60A | D70.11 | – | MD | 7 | 7.50 | 2659.84 | 379.98 | 2038.39 | +621.45 |
| 6 | Q60C | D70.10 | – | – | 5 | 6.90 | 2228.74 | 445.75 | 1449.79 | +778.95 |
| 7 | Q61D | D59.2 | R50.9 | – | 4 | 6.70 | 2207.35 | 551.84 | 1608.46 | +598.89 |
| 8 | T64C | A49.9 | R50.2 | D70.10 | 6 | 5.80 | 1899.49 | 316.58 | 1808.21 | +91.28 |
| 9 | J62B | C50.8 | R50.2 | – | 5 | 3.60 | 1345.87 | 269.17 | 1623.90 | –278.03 |
| 10 | J62B | C50.4 | – | D70.10 | 5 | 3.60 | 1345.87 | 269.17 | 1496.73 | –150.86 |
| 11 | J62B | C50.4 | – | D70.10 | 5 | 3.60 | 1266.49 | 253.30 | 1462.04 | –195.55 |

MD = Main diagnosis, SD = secondary diagnosis, LOS = length of stay.

G-CSF and erythropoietin were used in 18.2% and 9.1% of episodes, respectively. Antipyretics and fluid substitution were necessary in 18.2% and 54.5% of episodes, respectively. In 72.7% of episodes, other medications were taken due to minor concomitant comorbidity. Low-molecular heparins were given to all patients for prophylaxis of thrombosis. The most relevant diagnostic procedures were blood tests (100%) and microbiology testing (90.1%).

*Costs and Revenues*

Hospital costs for in-patient FN treatment (n = 11) were altogether € 18,288, on average (Ø) € 1663/case (range € 1139–2344) (table 2). The DRG revenues were altogether € 23,593, Ø € 2145/case (range € 1266–2660). A comparison of the individual DRG revenues with the actual hospital costs for in-patient FN treatment showed that the DRG revenues (€ 23,593) exceeded the hospital costs (€ 18,288) with an incremental gain of € 5305 or € 482/case (table 2). A case-by-case comparison revealed that n = 8 out of 11 FN episodes (72.7%) were not only cost covering but also resulted in a financial gain (range € +9 to +1521). Only n = 3 cases (27.3%) were loss generating (range € –151 to –278).

*Medical Coding and Revenues*

International Classification of Diseases (ICD-10) codes D70.– for agranulocytosis and neutropenia were only coded in n = 6/11 cases as main and in n = 3 cases as secondary diagnosis, fever R50.– only in n = 4/11 cases as secondary diagnosis. Sepsis, e.g. A40.– or A41.–, was never coded. A financially disadvantageous main diagnosis was used in n = 4 cases with n = 3 C50.– breast cancer and n = 1 A49.9 unspecified bacterial infection. The final DRG codes resulted in 7 Q-DRGs (table 2; 1–7), 3 J-DRGs (9–11) and 1 T-DRG (8). All Q-DRGs (n = 7) were cost covering from the hospital's perspec-

tive; however, the T-DRG (n = 1) was only marginally cost covering. In contrast, all J-DRGs (n = 3) were loss generating (table 2). Therefore inadequate DRG coding (n = 4/11; 36.4%) by not defining drug-induced FN (D70.1–) as main or secondary diagnosis resulted in reduced revenues of Ø € 1464 per case instead of Ø € 2534, a loss of € 1069/case (–42.2% of the average Q-DRG).

## Discussion

In this study actual costs and DRG revenues of in-patient treatment for FN in pBC were compared for the German DRG system for the first time [12]. Models based on quality-adjusted life years (QALYs) for determining cost-effectiveness of prophylaxis medication for FN [16] have only limited value from the provider's perspective. Usually, FN costs, outcomes and their implications are investigated [17–19]. But the mandatory introduction of the DRG reimbursement system for in-patient therapy in Germany in 2004 and its implications to provide care at non-revenue-exceeding costs forces physicians to increase their cost awareness and consecutively to an adjustment of care to revenues. Out-patient treatment of FN has been advocated over more than a decade [20–23] and a classification system for different FN risks [24] with risk-adjusted out-patient treatment was developed and evaluated [25, 26]. But despite its potential for a better cost-effectiveness [21], until the present time out-patient treatment of FN in low-risk groups is not the adopted standard of care in Germany, so far. Interestingly, the charges for in-patient FN can vary dramatically, even among low-risk patient groups, in different countries, e.g. between the USA and Germany. For almost identical lengths of hospital stay of 5.7 versus 5.4 days for FN treatment, the total mean charges in the USA were within a low-risk group of n = 126 in-patients $ 13,614–16,849 compared to only € 2144.82 (€ 1266–2660) in this study of n = 11 patients, a difference of about 6–12-fold [19]. The non-existing profit margins in the German DRGs explain why German hospitals are explicitly and increasingly aggressively comparing their own costs and revenues, to consequently adjust their medical care to the revenues. As an example, it is evident from the DRG revenues for chemo-induced FN that, due to its costs, Neupogen® (filgastrim) is often preferred to Neulasta® (pegfilgastrim) in case of in-patient G-CSF application [9, 27].

Interestingly, this comparison of hospital costs and DRG revenues for in-patient treatment of FN during adjuvant chemotherapy in pBC patients reveals that, on average, the hospital revenues were exceeding its costs by +29.0%. Since the DRG system intended no profit margin, it must be assumed that this group of pBC patients might not be representative regarding costs and resources for FN patients of all different cancer entities like leukemia, metastasized or late-stage and prefinal diseases, which likely were summarized in this DRG category for FN treatment. Diagnosis of sepsis is also missing in all of these FN patients, which is suggested for neutropenia according to the German Coding Guidelines [28]. Several parameters support that this study group of relatively young age, with on average 57.4 years, otherwise healthy status with an ECOG 0 of 100%, no severe comorbidity, non-pretreated patients (= without previous myelosuppressive therapy), is of low risk for severe FN. Other signs are that, with 5.4 days, the length of hospital stay was below the DRG average of 6.1 days, no in-patient complication occurred, and 100% returned to normal after discharge. As a consequence of asymmetrical cost distribution, these results suggest that the DRG for FN treatment might be split by the InEK between relatively healthy FN patients like pBC and more sick patients with severe immunosuppression or late-stage diseases. In the meantime, the German Institute for Medical Documentation and Information (DIMDI) has published a splitting of the diagnosis in the ICD-10 German Modification (GM) according to length of critical phase with neutrophil granulocytes of < 500 or leucocytes with < 1,000/µl blood per FN period (D70.10 < 4 days, D70.13 4– < 7 days, D70.14 7– < 10 days, D70.11 10– < 20 days, and D70.12 > 20 days) [29]. Refining of the DRG system will now move CTX-induced FN as in-patient treatment into Q60C, with a reimbursement of € 1977.43/case. For low-risk FN patients, DRG Q60A will not result anymore and, as a consequence, has changed and increased its value to € 4140.13/case in 2011 according to the DRG browser V2009/2011HA [30]. This will reduce the financial gains found in this study, reflecting an increasingly more accurate cost calculation in the DRG system, which was intended as a learning system.

Despite the fact that in-patient chemo-induced FN as main diagnosis leads to Q-DRG, coding mistakes in 3 cases of a J-DRG and in 1 of a T-DRG resulted in much lower DRG revenues. In these 4 cases, D70.1– pharmaceutical-induced agranulocytosis and neutropenia was neither considered as main diagnosis nor coded. The remarkable loss of Ø € 1069 for each of these 4 cases demonstrates the importance of comprehensive and completely correct coding combined with medical knowledge of all cases, clinical costs and consumption of resources, to assure cost coverage of in-patient FN treatment from the provider's perspective.

## Disclosure Statement

The authors declare no conflict of interests.

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